

**APPLICATION**  
**FOR**  
**UNITED STATES LETTERS PATENT**

**TITLE: METHOD OF MANUFACTURING A WAFER ASSEMBLY**

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## Method of manufacturing a wafer assembly

### Field of the invention

The invention concerns a method of manufacturing a wafer assembly  
5 comprising a chip wafer onto which a cover wafer is deposited. The  
invention also concerns a method of manufacturing a portable device  
comprising a support layer provided with a cavity. The portable device  
can be, for example, a smart card or a Subscriber Identification Module  
(SIM) card.

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### Background of the invention

WO 00/63836 discloses an integrated circuit device comprising an active  
layer made of semiconductor material ; an integrated circuit having one  
15 active surface of said active layer, whereby the integrated circuit has  
circuit elements and at least one contact flush with said active surface; an  
additional layer fixed to the active surface, whereby said additional layer  
at least partially covers the integrated surface of the active layer. A hole is  
made in the additional layer, whereby said hole is perpendicular to at  
20 least one circuit element.

### Summary of the invention

It is an object of the invention to allow both a reduction of the cost and an  
25 enhanced quality.

According to an aspect of the invention, a method of manufacturing a  
wafer assembly comprising a chip wafer onto which a cover wafer is  
deposited, the chip wafer comprising an active face and an inactive face,

the active face comprising chip elements, the cover wafer being provided with a chip-element-receiving cavity located above a chip element, the method comprising the following steps:

- 5       - a cover-wafer-depositing step, in which a cover wafer is deposited on the active face so as to obtain a wafer assembly, the cover wafer being provided with a plurality of chip-receiving cavities, a chip-receiving cavity being located above a chip element, the cover wafer being made of an organic material;
- 10       - a wafer assembly thinning step, in which the inactive face of the chip wafer is thinned.

The chip wafer comprises, for example, GSM chip. The chip receiving cavity is arranged to receive, for example, an RF chip.

- 15       By thinning the chip wafer, RF chips can be stacked on each GSM chip of the chip wafer so as to obtain a plurality of chip assemblies the thickness of which is substantially the same as a non-thinned GSM chip. In addition the cover wafer enables strengthening the thinned chip wafer thus reducing the risk of damages, for example, during the manufacturing
- 20       process. As the cover wafer is made of an organic material, the cover wafer can be easily deposited using, for example, well-known spin-coating depositing processes. Furthermore, the invention avoids designing a unique integrated circuit comprising the functionalities of both the GSM chip and the RF chip.
- 25       The invention thus allows both a reduction of the costs and an enhanced quality.

**Brief description of the drawings**

- Figure 1 illustrates a first chip wafer (CHIPW1) ;  
Figure 2 illustrates a coating-depositing step ;  
Figure 3, illustrates a first opening-creating step;  
5 Figure 4 illustrates a cover wafer (COV) ;  
Fig 5 illustrates a second opening-creating step;  
Figure 6 illustrates a cover-wafer-depositing step ;  
Figure 7 illustrates a wafer-assembly-thinning step;  
Figure 8 illustrates a second chip wafer;  
10 Figure 9 illustrates a second-chip-wafer-cutting step ;  
Figure 10 illustrates a chip-placing step ;  
Figure 11 illustrates a chip-assembly-fixing step;  
Figure 12 illustrates a connecting step;  
Figure 13 illustrates a resin-depositing step.

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**Detailed description**

- As illustrated in figure 1, a first chip wafer (CHIPW1) having a thickness of, for example,  $680\mu\text{m}$  is used. The first chip wafer (CHIPW1) comprises  
20 an active face (ACTIVF) provided with chip elements and an inactive face (INACTIVF). The chip elements can be, for example, GSM chips, that is to say chips designed to be used in a mobile phone. The wafer is made, for example, of silicon.
- 25 As illustrated in fig 2, if needed, in a coating-depositing step, an adhesive layer (ADHES) is deposited on the active face (ACTIVF) of the first chip wafer (CHIPW1). The adhesive layer, comprises, for example, a polymer. The polymer, can be, for example, a photosensitive polymer.

As illustrated in figure 3, in a first opening-creating step, openings are created in the photosensitive polymer using a mask and UV.

As illustrated in figure 4, a cover wafer (COV) having a thickness of, for example, 280 $\mu$ m is used. The cover wafer (COV) can be made of any other material that can be etched, for example, a photosensitive material. It can be, for example, Benzo Cyclo Butène (BCB), a polyimide material, or well-known epoxy based material.

As illustrated in figure 5, in a second opening-creating step, vias (V) and chip-receiving cavities (CS) are created in the cover wafer. The second opening-creating step can be done, for example, using etching techniques. In particular, wet etching techniques or dry etching techniques can be used. In a cover-wafer-thinning step, the cover wafer is thinned, for example, to 140  $\mu$ m.

As illustrated in figure 6, in a cover-wafer-depositing step, the cover wafer (COV) is deposited on the adhesive layer (ADHES) of the first chip wafer (CHIPW1) so as to fix the cover wafer (COV) on the first chip wafer (CHIPW1). A wafer-assembly (WAFA) is thus obtained. If there is no adhesive layer, the cover wafer can be directly deposited on the active face of the chip wafer. Advantageously the cover wafer is an organic layer. The cover layer can thus be directly deposited on the active face of the chip wafer using, for example, spin-coating techniques. Advantageously the cover wafer is a photosensitive material so that openings can be easily created using well-known etching techniques.

As illustrated in figure 7, in a wafer-assembly-thinning step, the wafer-assembly (WAFA) is thinned down to, for example, 190  $\mu$ m at the level of

the inactive face (INACTIVF) of the first chip wafer (CHIPW1). The wafer-assembly-thinning step can be done using, for example, a polishing device. The cover wafer allows strengthening the thus thinned wafer-assembly. In addition, as the cover wafer has a thickness greater than  
5 10 $\mu$ m, advantageously greater than 100  $\mu$ m, for example 140  $\mu$ m, it is easy to manipulate the wafer-assembly during the manufacturing process.

As illustrated in figure 8, a second chip wafer (CHIPW2) is used. The second chip wafer (CHIPW2) comprises an active face (ACTIVF) provided  
10 with chip elements. The chip elements can be, for example, RF chips. In a second-wafer-thinning step, the second chip wafer is thinned down to, for example, 140 $\mu$ m.

As illustrated in figure 9, in a second-chip-wafer-cutting step, the second  
15 chip wafer is cut so as to obtain separated RF chips.

As illustrated in figure 10, in a chip-placing step, the separated RF chips are placed in the chip-receiving cavities (CS) of the wafer assembly (WAFA).  
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In a wafer-assembly cutting step, the wafer assembly comprising the RF chips is then cut so as to obtain separated chip assembly (CHIPA) comprising a GSM chip on which is stacked an RF chip.

25 As illustrated in figure 11, in a chip-assembly-fixing step, a chip assembly (CHIPA) is fixed on a support layer (SL) comprising contact pads. The support layer comprises, for example, epoxy resin.

As illustrated in figure 12, in a connecting step, the RF chip and the GSM chip of a chip assembly (CHIPA) are connected to the contact pads of the support layer (SL) using bonding wires.

- 5 As illustrated in figure 13, in a resin-depositing step, a resin material is deposited on a chip assembly and the bonding wires so as to protect them.

The description hereinbefore illustrates a method of manufacturing a wafer assembly comprising a chip wafer onto which a cover wafer is deposited, the chip wafer comprising an active face and an inactive face,  
10 the active face comprising chip elements, the cover wafer being provided with a chip-element-receiving cavity located above a chip element, the method comprising the following steps:

- a cover-wafer-depositing step, in which a cover wafer is deposited  
15 on the active face so as to obtain a wafer assembly, the cover wafer being provided with a plurality of chip-receiving cavities, a chip-receiving cavity being located above a chip element, the cover wafer being made of an organic material;
- a wafer assembly thinning step, in which the inactive face of the  
20 chip wafer is thinned.

The chips or chip elements can be, for example, RF chips, or chips comprising functionalities for the reducing of the risk of current analysis based attacks (= DPA chips). GSM chips, memory chips, Micro Electrical  
25 Mechanical Systems (MEMS), silicon sensors, Micro Optical Electrical Mechanical Systems (MOEMS) or any other type of integrated circuits can also be used.

The invention also concerns a method of manufacturing a portable device comprising a support layer provided with a cavity. The method comprises a chip-assembly-fixing step, in which a chip-assembly according to the invention is fixed in the cavity.